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ABSTRACT

Junior high school students (N=104) were given instruction using programed booklets on modular addition. Twelve conditions of verbal mediation were randomly assigned to students. Conditions were defined by presence or absence of introductory discussion (2 levels), number of worked examples (2 levels), and type of rule (3 levels: specific, general, none). After instruction, subjects were tested for three types of transfer: specialization, generalization, and reasoning by analogy. The use of a concrete model as introductory was found to have a significant (p less than .05) facilitating effects on specialization and a less-pronounced effect on generalization. For all three levels of transfer, the groups given specific or general rules performed better than those given no rule. Limitations of the study and suggestions for further research are discussed. (SD)

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VERBAL MEDIATORS IN MATHEMATICS FOR TRANSFER OF LEARNING

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The problem of transfer of learning, which can be described as a concern about how immediate skills, understanding, attitudes and other learned functions influence behavior in a diversity of subsequent situations, has been a topic for numerous research studies and theoretical writings. Wittrock (1968) proposes an approach to research on transfer of learning which involves the use of a theoretical model. One of the models he proposes, is called a mediated generalization model or mediated verbal transfer model. A mediated generalization model provides a useful way to conceptualize verbally mediated transfer; this means that words and other verbal stimuli are used to make distinctions and generalizations not readily apparent to the learner otherwise. Studies by Wittrock and his associates (Wittrock, 1963 b; Wittrock & Twelker, 1964; Wittrock, Keislar & Stern, 1964; Wittrock, 1967; Wittrock, 1969) dealt with the effects on learning, retention and transfer of such verbal mediators as rules and examples.

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Though the result of these studies appear to be highly relevant to instruction, the generalizability of the findings beyond the learning laboratory is somewhat doubtful because of the type of learning tasks used (abstract card tasks, cryptograms, coded sentences and the like).

This study was an investigation of the effect of selected verbal mediators on levels of learning transfer that may occur from learning mathematical concepts in a classroom situation.

Method

The mathematical subject matter of modular addition was taught to the experimental subjects by means of programmed booklets prepared by the investigator. The verbal mediators used were: introductory material (IM), examples (Ex) and rules (R). The IM consisted of a presentation of addition on a 12-hour clock, illustrated with diagrams. The Ex consisted of addition modulus five (mod 5) or addition mod 5,mod 6 and mod 7 respectively. Two types of R were used, called specific rule (SR) and general rule (GR). SR was a definition of addition mod 5 and GR was a definition of addition mod n. The levels of transfer investigated were specialization, generalization and reasoning by analogy. Specialization was operationally defined as passing from addition mod 5 to addition mod 3 and 4. Generalization was operationally defined

as passing from addition mod 5 to addition mod n, and reasoning by analogy was defined as passing from addition mod 5 to multiplication mod 5. The terms specialization, generalization and reasoning by analogy were used in accordance with the interpretation given to them by Polya (1954).

The three verbal mediators used in the study determined the three independent variables; they were: IM (with two levels: use of IM and no IM), Ex (with two levels: one Ex and three Ex), and R (with three levels: SR, GR and no R (NR)). Thus the experimental design was a 2 x 2 x 3 factorial design with fixed effects.

The specific questions asked were:

1. Does the use of concrete models of a mathematical concept presented to the learner as a verbal mediator facilitate the levels of transfer identified as generalization, specialization and reasoning by analogy ?

2. Does the use of three examples rather than one example of a mathematical concept presented to the learner as a verbal mediator facilitate the levels of transfer identified as generalization, specialization and reasoning by analogy ?

3. Does the use of rules presented to the learner as verbal mediators facilitate the levels of transfer identified as generalization, specialization and reasoning by analogy ?

These questions gave rise to three major hypotheses:

1. The mean test score for the IM-group will be significantly

higher than the mean test score for the no-IM group on each of the three levels of transfer.

2. The mean test score for the three Ex-group will be significantly higher than the mean test score for the one Ex-group on each of the three levels of transfer.

3. There will be significant variation of mean test scores across levels of rule given in the performance on each of the three levels of transfer.

Instructional booklets and the criterion tests which were designed to measure specialization, generalization and reasoning by analogy, were pilot tested in two pilot studies. The population for the study consisted of 104 seventh grade students at Leander Junior High School, Leander, Texas. The subjects were randomly assigned to twelve treatment groups resulting from the 2 x 2 x 3 factorial design. The experiment was administered by the investigator during five days. Instruction was given during three days and two days were used for testing. The validity of the three transfer tests as a measure of the levels of transfer was judged by three mathematics educators who also judged the tests to be valid as measures of the content taught. As a reliability measure Cronbach's alpha (1951) was used which was .90 for the Specialization Test (Test 1), .83 for the Generalization Test (Test 2) and .85 for the Analogy Test (Test 3).

Results

The performance of subjects in different treatment groups was compared using a three-way analysis of variance. The actual computations for the data analysis were carried out using Veldman's (1967) computer program AVAR23. The means and standard deviations for Test 1, Test 2 and Test 3 are given in Table 1.

Insert Table 1 about here

The analysis of variance summaries for each one of the three tests are presented in Tables 2, 3 and 4 respectively.

Insert Table 2 about here

Insert Table 3 about here

Insert Table 4 about here

From Tables 2, 3 and 4 can be seen that the use of IM produced an effect significant at the .05 level on

Test 1. For Test 2 the F-test failed to reach significance at the .05 level, however, the associated probability p was .099, suggesting that a consistent effect may have been present but not to a significant degree. For Test 3 the F-test failed to reach significance. Tables 2, 3 and 4 also indicate that the F-tests for the 'number of examples' main effect yielded no significant difference for any of the critical variables. Furthermore, Tables 2, 3 and 4 show that for the Rule contrast the F-tests for Test 1 and Test 3 reached significance at the .05 level, while the F-test for Test 2 did not reach significance; the probability associated with the F for Test 2, however, was .06, suggesting that a consistent effect was present, but not to a significant degree. Since Hypothesis 3 was statistically confirmed at the .05 level for Test 1 and Test 3 and at the .06 level for Test 2, pairwise t-tests were used to compare the SR-group and the NR-group, and the GR-group and the NR-group on all three tets. The results of these t-tests have been summarized in Tables 5 and 6.

Insert Table 5 about here

Insert Table 6 about here

Conclusions, Limitations and Discussion

Significant statistical evidence was found to indicate that the use of a concrete model of the mathematical subject matter presented to the subjects in this study did have a facilitating effect for the level of transfer designated as specialization. A certain consistency of the facilitating effect of the concrete model on specialization and generalization was also found, but the effect on generalization was not significant at the .05 level. The third level of transfer, however, designated as reasoning by analogy was not affected significantly by the use of IM as a verbal mediator. A possible explanation for this is that the learners who were able to transfer the principle of clock addition as suggested by the concrete model of the clock, did not see that the operation 'addition' was an integral part of that principle which could be replaced by 'multiplication' without changing the basic structure of the principle.

No evidence was found to support the hypothesis that the treatment group receiving three examples, would outperform on each of the three transfer tests the group receiving only one example. One possibility is that for the population of this study, the learning of modular addition was an 'all-or-none' phenomenon in the sense that the subjects learned everything from one example and nothing new from the two additional examples. An alternate explanation may be found

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in discussing a possible rationale for using three examples. That rationale seems to be that students will be able to see similarities between examples and 'abstract' principles which they then might transfer. If a (mathematical) subject matter is suffiently complex, however, this discovery of a principle from looking at several instances of it, may not take place.

Significant variation across levels of rule given provided evidence that there was difference in efficiency across the three treatments designated as NR, SR and GR, with the restriction that the significance level for the F-ratio for Test 2 was .06 and not .05 as had been anticipated. For all three levels of transfer, the 'rule-given' groups outperformed the NR-group. In general, it can be said that the rules presented as verbal mediators to the learner did enhance all three levels of transfer of the mathematical subject matter.

When evaluating the results and the conclusions, certain limitations should be considered. The sample was relatively small and limited. Only one junior high school was involved which was located in a rural area. Only one particular subject matter, modular addition, was taught and tested, therefore the results of this study may depend to a certain extent on the nature of the concepts involved. Instruction was provided by means of programmed booklets

which is quite different from a normal classroom situation. This investigator believes, however, that if a classroom teacher, even in a different school setting and a different age level, would use the same verbal mediators, the same kind of facilitating effect would be observed.

In considering implications of the foregoing results, it can be said that it seems possible to induce transfer of learning by means of appropriate verbal mediators. Especially rules and concrete models as verbal mediators seem to facilitate transfer of learning. Both these levels of mediators are particularly relevant to mathematics instruction, since many mathematical concepts can be summarized in the form of rules and illustrated by concrete models. This, of course, does not mean that these verbal mediators cannot be used in numerous other subject areas. It also seems possible to identify different levels of transfer which then can be facilitated by different verbal mediators. Matching a certain verbal mediator with a certain level of transfer may produce the largest amount of transfer. It also seems that transfer of learning is not automatic, since the treatment cells that did not receive any or all of the verbal mediators performed significantly lower on the transfer tests than the treatment groups presented with the verbal mediators. Thus, it seems that transfer of learning does not automatically follow from any kind of instruction; rather, if transfer is desired, one has to teach for transfer.

Cronbach, L.J. Coefficient alpha and the Internal Structure of Tests. Psychometrika, 1951, 16, 297-334.

Polya, G. Mathematics and plausible reasoning. Vol.1. Princeton: 1954.

Veldman, D.J. Fortran Programming for the Behavorial Sciences. New York: Holt, Rinehart & Winston, 1967.

Wittrock, M.C. Verbal stimuli in concept formation: Learning by discovery. Journal of Educational Psychology, 1963, 54, 183-90. (b).

Wittrock, M.C. Replacement and non-replacement strategies in children's problem solving. Journal of Educational Psychology 1967, 58, 69-74.

Wittrock, M.C. Three conceptual approaches to research on transfer of training. In Gagne & Gephardt (eds.) Learning research and school subjects. Los Angeles: Peacock Press, 1968.

Wittrock, M.C. Transfer of Rules:The need for tests of transfer in the evaluation of instruction. Center for the Study of Evaluation Working Paper, University of California at Los Angeles, 1969, 3.

Wittrock, M.C. & Keislar, E.R. Verbal cues in the transfer of concepts. Journal of Educational Psychology, 1965, 56, 16-21.

Wittrock, M.C., Keislar, E.R. & Stern, C. Verbal Cues in concept identification. Journal of Educational Psychology, 1964, 55, 195-200.

Wittrock, M.C. & Twelker, P.A. Prompting and feedback in the learning, retention and transfer of concepts. British Journal of Educational Research, 1964, 34, 10-18. (a)

Wittrock, M.C. & Twelker, P.A. Verbal cues and variety of classes in transfer of training. Psychological Reports, 1964, 14, 827-830. (b).

TABLE 1

Means and Standard Deviations for Tests 1, 2 and 3

	Test 1 (Specialization)	Test 2 (Generalization)	Test 3 (Analogy)
Mean	15.07	9.96	15.08
σ	6.33	4.48	5.07
n	83	85	78
Max. Score	25	18	23

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TABLE 2

Analysis of Variance Summary Table for Test 1 (Specialization)

Source	df	MS	F-ratio	p
Total	82	39.13		
Between	11	58.35		
Introductory Material	1	217.59	6.08	.02*
Examples	1	1.46	.04	.84
Rules	2	150.92	4.1[illegible]	.02*
IM X EX	1	13.62	.38	.5[illegible]
IM X R	2	21.25	.59	.56
Ex X R	2	8.88	.25	.79
IM X Ex X R	2	23.53	.65	.58
Within	71	36.15		

* significant at the .05 level

TABLE 3

Analysis of Variance Summary Table for Test 2 (Generalization)

Source	df	MS	F-ratio	p
Total	81	20.62		
Between	11	22.37		
Introductory Material	1	55.34	2.72	.10
Examples	1	5.72	.28	.60
Rules	2	57.15	2.81	.06
IM X Ex	1	14.88	.73	.40
IM X R	2	5.84	.29	.76
Ex X R	2	11.10	.55	.59
IM X Ex X R	2	10.96	.54	.59
Within	70	20.35		

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TABLE 4

Analysis of Variance Summary Table for Test 3 (Analogy)

Source	df	MS	F-ratio	p
Total	73	26.39		
Between	11	35.39		
Introductory Material	1	11.08	.45	.51
Examples	1	6.60	.27	.61
Rules	2	113.41	4.47	.01*
IM X Ex	1	2.55	.10	.75
IM X R	2	31.34	1.26	.29
Ex X R	2	18.68	.75	.48
Within	62	24.80		

* significant at the .05 level

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TABLE 5

t-Test Summary Table for Comparison of NR - Group and SR-Group

	Test 1 (Specialization)		Test 2 (Generalization)		Test 3 (Analogy)	
	NR	SR	NR	SR	NR	SR
Mean	12.46	16.57	8.12	10.61	11.46	15.33
df	52		52		49	
t	2.53		2.21		2.99	
p	.01*		.03*		.005*	
n	26	28	26	28	24	27

* significant at the .05 level

TABLE 6

t-Test Summary Table for Comparison of NR - Group and GR-Group

	Test 1 (Specialization)		Test 2 (Generalization)		Test 3 (Analogy)	
	NR	GR	NR	GR	NR	GR
Mean	12.46	16.24	8.12	10.36	11.46	14.35
df	53		52		45	
t	2.29		1.92		2.04	
p	.02*		.056		.04*	
n	26	29	26	28	24	23

* significant at the .05 level